APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS IN UNITED STATES AIR FORCE EMERGENCY MANAGEMENT OPERATIONS

GRADUATE RESEARCH PROJECT

Anthony A. Higdon, Major, USAF

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Anthony A. Higdon, BS, MA

Major, USAF

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Anthony A. Higdon, BS, MA
Major, USAF

Approved:

/signed/ 20 Sep 04

David D. Bouvin (Chairman) date

AFIT/MGM/ENV/04S-01

Abstract

This research investigated the applications of GIS in emergency management operations specifically response to certain types of natural disasters and accidents both in general and in the USAF. The research objective was to determine the benefits the USAF can obtain from the use of GIS for emergency management operations and to examine some of the USAF efforts underway.

The research methodology consisted of a literature review of academic, commercial, and USAF documents. The research determined the effective execution of emergency plans and response requires a means to communicate situational awareness which can be effectively imparted by shared access and the use of geospatial data such as imagery, maps, and locator/routing tools.

Further evaluation of USAF Full Spectrum Threat Response plans and checklists to determine if all functional areas are developing the proper geospatial data within the GeoBase framework to effectively support emergency management operations is recommended. Additionally, an analysis of two on-going GIS program applications within the USAF is recommended to determine applicability for USAF-wide implementation.

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Anthony A. Higdon

Table of Contents

List of Figures

Page

APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS IN UNITED STATES AIR FORCE EMERGENCY MANAGEMENT OPERATIONS

I. Introduction

A Geographic Information System (GIS) is a system of hardware, software, and data used to link geospatial data with attribute data (19:2; 24; 25:173). Geospatial data is data about objects and their position on earth (spatial coordinates) and the attribute data is information that describes the geospatial data such as name, characteristics, etc. (19:2; 23:3; 24; 25:173). A GIS enables query, analysis, and presentation of geospatial data on map layers together with the accompanying nongraphic attribute data providing the benefits of both traditional maps and relational databases (19:2; 23:4).

According to Cova, "Hoetmer defines emergency management as the discipline and profession of applying science, technology, planning and management to deal with extreme events that can injure or kill large numbers of people, do extensive damage to property, and disrupt community life" (3:845). Emergencies can be caused by natural events (e.g. hurricanes and tornados), accidents (e.g. hazardous material spills), or intentional attack (e.g. terrorist bombings or release of chemical agents).

The purpose of this paper is to examine the benefits of applying GIS technology to emergency management planning and response in a general context and specifically within the U.S. Air Force (USAF). The application of GIS in emergency management is a very broad topic that has a large body of literature which cannot be completely

examined in a small research effort such as this. Therefore, to maintain focus, this paper will narrow the discussion to the benefits of GIS for planning and responding to certain types of natural disasters and accidents. The paper will provide a perspective on how the USAF can use GIS in emergency response and take a look at some of the USAF efforts underway to implement the use of GIS for emergency response.

II. Literature Review

Geographic Information Systems

According to a report by the Government Accounting Office (GAO), "The primary function of a GIS is to link multiple sets of geospatial data and graphically display that information as maps with potentially many different layers of information" (19:2). The many different layers of data (such as roads, structures, utilities, topography) gathered about a specific geographic location can be displayed in a combined manner providing a better overall understanding of the situation (20:9). A paper written by the US Army Corps of Engineers' CADD/GIS Technology Center states,

> GIS combines the use CADD [computer-aided design and drafting] technology with relational database management system (RDBMS) technology to relate data to features on digital maps and drawings and to allow for the creation, storage, maintenance, retrieval, query, analysis, and display of various geospatial information. (23:3)

A GIS is very flexible and can tie together geospatial information that is collected by various sources (such as photographs from remote sensing systems or inputs using Global Positioning System (GPS) coordinates) and maintained by different organizations (19:2-3; 20:9; 23:4).

These features of a GIS make it a superb tool especially in the context of this quote by Pratt, "The map, a uniquely concise and elegant communication medium, makes complex information instantly comprehensible in a way not possible with text or tables" (21:S3). The importance and usefulness of a GIS becomes even more clear if, as the GAO reports the Department of Interior has determined, "…about 80 percent of

government information has a geospatial data component, such as an address or other reference to a physical location" (19:5).

Emergency Management

A review of literature focused on the application of GIS use in emergency management reveals slightly varying, but generally consistent frameworks for emergency management. According to Cova, one model for emergency management is called *comprehensive emergency management (CEM)*. CEM is comprised of four phases: mitigation, preparedness, response, and recovery (3:846). Another model described by Johnson includes five phases: planning, mitigation, preparedness, response, and recovery (18:2-3). In the model described by Johnson, planning is an overarching phase that encompasses the activities to analyze and document potential emergencies and associated consequences. The planning phase also covers assessing the hazards and risks and the needs of the other four phases to manage those hazards and risks (18:2).

Mitigation.

In both models mitigation includes taking action to reduce or eliminate the long-term risks to humans and property associated with the identified hazards. Mitigation may include actions such as zoning to prevent building in flood-prone areas or clearing vegetation in areas at high risk for wildfires. (3:846-7; 13:137; 18:2)

Numerous applications of GIS in emergency mitigation have been cited in the literature. The recurring themes deal primarily with five major areas (3:848-850; 13:137-8; 17:1-5; 18:4; 21:S3). The first is identification of potential flood zones for both inland and coastal hurricane surge flooding. The second is identification of potential fire

hazards and areas at risk. The third is identification of areas vulnerable to earthquakes along fault lines. The fourth area is identification of critical infrastructure choke points such as a bridge that has electrical and telecommunications lines running across the bridge structure that is also the single egress point from an island. The fifth common theme is the identification and location of critical resources (e.g. hospitals, power plants, and emergency response facilities) that are at risk. In all of these cases, the literature highlights changes in land use controls (e.g. vegetation management to reduce fire hazards) and comprehensive community planning (e.g. developing zoning ordinances to control development) as the outcomes of using GIS in emergency mitigation. In addition, GIS has been used to quantify, in terms of number of human lives and cost of facilities and infrastructure, how much is at risk in the specific hazard zones (18:4).

Preparedness.

Preparedness includes activities to prepare operational response to emergency situations that can not be eliminated with mitigation steps. The preparedness activities occur prior to an actual emergency and are designed to ensure plans are developed to respond effectively with appropriate resources. Preparedness activities include designating emergency response force allocation, designating evacuation routes, conducting exercises and training, stockpiling resources, and inventorying available response resources (3:846-7; 13:137; 18:2-3).

The literature discusses many applications of GIS for preparedness. Identifying evacuation routes, the best locations for emergency shelters and inventories of emergency response resources (e.g. supplies, equipment, vehicles, and mutual aid availability) are among the applications. (3:850-3; 13:137-8; 18:4). Additionally, such tasks as

identifying how many paramedics a city requires, as well as, the best locations to stage them so they can meet appropriate response times can be accomplished using GIS (18:4).

Perhaps one of the most cited uses of GIS in emergency preparedness is obtaining and maintaining orthophotos, blueprints, and other critical information about specific facilities. This is particularly true for facilities that process, use, or store large quantities of hazardous materials (HAZMAT). Maintaining data regarding the hazardous materials (e.g. quantities, specific storage locations, characteristics, and appropriate emergency response measures) at a given facility enables first responders to have situational awareness prior to arriving on the scene. In addition, remote sensing to detect hazard levels enables real-time notification when spills or leaks occur (1; 3:850-3; 25:172-7).

Another oft-cited application of GIS for emergency preparedness is the mapping of infrastructure (e.g. roads, railroads, bridges, and traffic control points) as well as utility grids (e.g. electric, water, gas, sewer, and telecommunications) to ensure quick access once an emergency response has been initiated (1; 3:850-3; 13:138; 18:2-6).

Response.

Response includes the actions taken immediately before, during, and immediately following an emergency event (3:846-7; 13:137). The response activities are intended to save lives, minimize property damage and stabilize the situation to improve the recovery efforts. Some of the specific activities associated with response include fire fighting, evacuation, medical treatment, search and rescue, isolating utilities, constructing barriers to prevent further flooding, and initial damage assessment. (3:847; 13:137; 18:2).

During an emergency, the ability to quickly map an area and obtain associated data to further describe the spatial features on the map greatly increases the effectiveness

of emergency responders. Typically emergency responders (e.g. fire fighters, paramedics, police forces, hazardous material handlers) have very little time to arrive at the location of the emergency, assess the situation, and initiate evacuations in order to contain, minimize the damage, and prevent further damage due to the natural disaster or accident. Numerous applications of GIS have been cited to assist the emergency responders in these time-critical tasks, and nearly all of them rely heavily upon successful implementation of GIS applications in the preparedness phase. One of the most cited applications is the ability of a dispatcher to determine which response units are closest and can get to the site quickest, and the ability to specify which routes the responders should take to the scene. Automated (or Automatic) Vehicle Locators (AVL), a GPS technology that provides real-time information about the location of vehicles, can be overlaid on a GIS map providing dispatchers an assessment of where their response resources are located (1; 18:5; 26:830, 837). Additionally, a GIS can be used to identify the closest fire hydrants, electrical panels, hazardous materials, and the floor plans for a facility while the fire fighters are still enroute to the scene (1; 3:850-3; 8:12; 18:4-5).

Using real-time weather data and the geographic characteristics of the surrounding area, GIS applications can be used for plume-modeling enabling emergency responders to quickly determine the extent of the hazardous area and establish appropriate hazard zones and initiate evacuations to clear the hazard zones. Establishing routes for evacuation and control points for police to prevent people from entering the hazard zones can also be accomplished quickly using GIS applications. Emergency responders can overlay the utility grid on the GIS-produced map to determine where shut-off valves are located enabling quick isolation of utility systems (e.g. shutting off

gas supply or shutting down storm drainage flows), if necessary. The hazardous material storage location data layer can be used to determine if there are any hazardous materials in the hazard zones that will be impacted mandating a need to increase the evacuation area (1; 3:851-4; 18:4-5; 25:174-6).

The visualization of the situation provided by the use of GIS for emergency response enables the emergency managers to see the whole picture and make informed decisions quickly. An example of using the whole picture to support decision making cited in an ESRI white paper involved the Federal Emergency Management Agency (FEMA) using GIS to identify areas of potential water contamination, as Hurricane Eduardo approached the U.S. coastline in 1996, enabling them to reposition fresh water stocks prior to the storm making landfall (8:10).

Tracking initial damage assessment reports is another activity that is well suited for completion using GIS applications. Plotting damage such as downed trees or power lines during a hurricane enable emergency dispatchers to avoid routes that may be impassible. Damage assessment maps are also one of the basic tools required in the recovery phase. (3:851-3; 18:5)

Recovery.

The recovery phase involves activities aimed at returning life to normal. Recovery is generally divided into short-term and long-term activities. Short-term activities involve establishing minimum essential life support activities such as providing temporary shelter or restoring water or electricity. Short-term recovery activities may be temporary in nature. Long-term activities include rebuilding personal, commercial, or

public property and infrastructure. Recovery activities may take many years to complete. (3:847; 13:137; 18:3).

The use of GIS applications most often cited in the recovery phase involve detailed damage assessment for the purpose of prioritizing repairs and applying for loans or grants to assist in rebuilding. In cases such as Hurricane Andrew or the Oakland, California, fire in 1992, where large areas were completely destroyed, leaving few visible landmarks, a GIS in conjunction with GPS can be used to verify the exact locations of the facilities destroyed. The positive location of structures that were destroyed is often vital to quickly enabling approval of loans or grants for rebuilding (3:851-3). According to the GAO, GIS data created during the response and recovery of the Space Shuttle Columbia accident not only enabled a more efficient recovery, but may also help experts in development of theories of why Columbia crashed (19:4).

III. Discussion

GIS in the USAF: GeoBase

While GIS is not new to the USAF, it was a new policy implemented in October 2002 that officially formed the USAF GeoBase program (27). In his policy memo, Lt Gen Zettler acknowledged that different mission functions (e.g. Civil Engineer, Safety, and Communications) had developed their own functionally-specific maps which did not provide leadership an integrated visualization of the overall situation. As a result, the GeoBase program has a vision of “One installation, one map.” This policy memo instituted the requirement for all Major Commands (MAJCOMs), Field Operating Agencies (FOAs), and Direct Reporting Units (DRUs) to implement a GeoBase program in accordance with the USAF GeoBase Concept of Operations (CONOPS) using national spatial data standards. As a result of the decision to use national standards, the GeoBase program is vendor-neutral, and much of the prior investment by installations can be retained (27).

According to the USAF Garrison Mapping Concept of Operations (Version 2.0), “GeoBase includes the people, processes, and resources used in the collection, analysis, and display of georeferenced information to support the installation mission” (7:5). The GeoBase program consists of four major visualization environments (7:4): Garrison GeoBase, Strategic GeoBase, the GeoReach Process, and Expeditionary GeoBase. Garrison GeoBase focuses on consolidating the disparate mapping efforts at permanent USAF installations and includes all details required for the installation mission. Strategic

GeoBase provides a limited view of the Garrison GeoBase maps (i.e. not all detailed layers) for use at Headquarters Air Force and higher levels. The GeoReach process provides planners and airmen visual intelligence to improve their ability to select forward operating locations, to conduct force size and flow planning, and to expedite bed-down of forces at selected operating locations in the USAF expeditionary role. Expeditionary GeoBase is a "lean, forward deployed version of Garrison GeoBase capabilities" which enables deployed commanders to obtain enhanced situational awareness (7:4). For purposes of this research, the focus will be on Garrison GeoBase.

The Garrison Mapping CONOPS highlights several issues that have caused problems based on the previous lack of a standardized GeoBase program. Among the issues are functional stovepiping (i.e. different functional areas developing their own automated information systems without a USAF standard) and fragmented situational awareness (i.e., leaders could not see all geospatial data integrated in a single map due to lack of a standard across each functional area). There are also several desired effects highlighted in the CONOPS. Key among them are: increased situational awareness, efficient and timely response to emergency situations, and increased ability to prevent, protect, and respond to terrorist and other threats to USAF installations. (7:1-3).

The "One installation, one map" vision is founded on the principal of geospatial data layers. The concept is for each installation to have a single Common Installation Picture (CIP) which is the basic level map that includes items such as boundaries, buildings, roads, airfield parking, runways, taxiways, elevation contours, etc. A list of the minimum required CIP features for all installations is included in the Appendix. The CIP is the standard map to be used by all functional areas. However functional areas

have the ability to add layers (called Mission Data Sets (MDS)) to support the functional-specific mission. A key facet of the Garrison Mapping CONOPS is that each functional specific MDS is designed, maintained, and controlled by the owning functional community, but the MDS must be compatible with the overall GeoBase structure. Functional communities may create a fused picture of the CIP with the required MDS to visualize the information they require to complete their mission (see Figure 1 below).

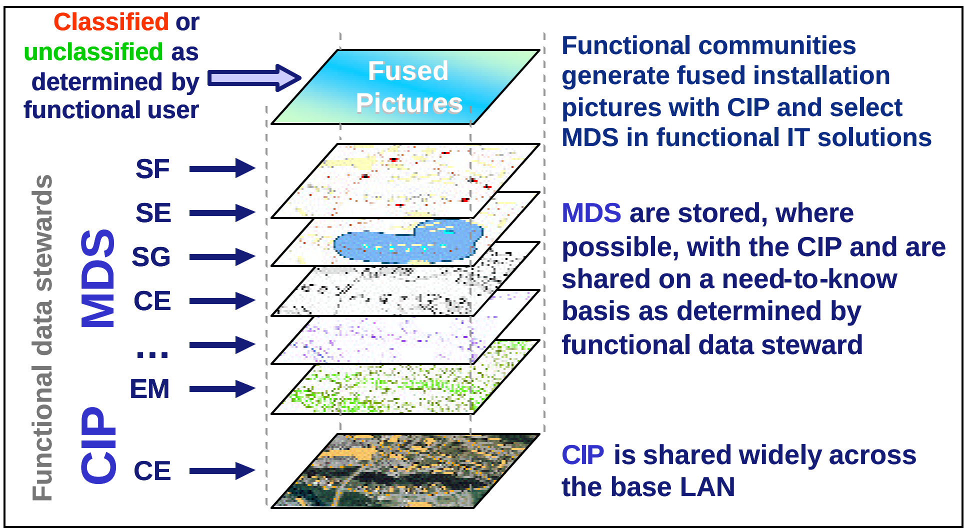

Figure 1. The Common Installation Picture and Mission Data Sets
(USAF Garrison Mapping CONOPS (Ver 2.0), Page 7, Figure 5-2)

In addition to the functional MDS, the Garrison Mapping CONOPS highlights that functional automated information system (AIS) System Program Offices (SPOs) are responsible for ensuring the systems are capable of interfacing with the GeoBase Service (CIP and MDS). Examples of these AISs included the Automated Civil Engineer System (ACES) maintained by the Air Force Civil Engineer Support Agency (AFCESA), the

C4ISR Infrastructure Planning System (CIPS) maintained by the 38th Engineering Installation Group (38 EIG), and the Assessment System for Hazard Surveys (ASHS) maintained by the AF Safety Center (AFSC) (7:17-19).

Emergency Management in the USAF: FSTR

The USAF emergency management function falls under the domain of the Full Spectrum Threat Response (FSTR) program. Air Force Instruction (AFI) 10-2501, *Full Spectrum Threat Response (FSTR) Planning and Operations*, defines FSTR as: "Physical threats facing military installations including major accidents, natural disasters, HAZMAT, terrorist use of WMD, enemy attack, and a broad spectrum of planning, response, and recovery activities." (6:100) WMD is an acronym for Weapons of Mass Destruction. The FSTR program is owned by the Commander of an installation and involves all organizations on the installation, but the program is administered by the Civil Engineer Squadron Readiness Flight.

The FSTR organization at an installation is composed of two elements: Planning & Management and the Disaster Response Force (DRF) (6:10). The planning and management element includes the FSTR program manager, the installation Readiness Board, the Exercise Evaluation Team, and the individual unit program monitors. The DRF includes the Command Post and Survival Recovery Center (SRC), Disaster Control Group (DCG), the unit control centers (UCC), the support and recovery teams, and the emergency services (fire, medical, security forces). The Disaster Control Group is the cross-functional support staff for the On-scene commander. Some of the more common support and recovery teams are the HAZMAT Response team, Shelter Management

Team, Contamination Control Team, and Mortuary Search and Recovery Team. The UCCs provide reach back capability for the functional area experts on the DCG, as well as, monitor and control the unit specific activities required to support the emergency response and recovery (except for the forces under the direct control of the On-scene Commander). Each major organization on an installation has a UCC.

The FSTR program is not specifically divided into mitigation, preparedness, response, and recovery, but the program entails all of the typical activities associated with emergency management in addition to aspects related to attack on an installation during war.

Each installation is mandated by AFI 10-2501 to develop a FSTR Plan 10-2 complete with associated checklists. The Air Force Civil Engineer Support Agency (AFCESA), in conjunction with functional experts throughout the USAF, has developed templates for the FSTR Plan 10-2 and the associated functional checklists.

Applications of GeoBase in FSTR

Based on the limited scope of this research endeavor, the focus for the remainder of the paper will be a review of items found in AFI 10-2501, AFMAN 32-4004 and some of the associated checklists to identify areas which can or do benefit from the use of GeoBase to improve the USAF emergency management capabilities. The focus will be in the response category to major accidents and natural disasters. This is by no means an exhaustive review from two aspects: first, not all threats will be evaluated (e.g. enemy attack), and second, not all functional checklists will be reviewed.

One of the simplest applications of GeoBase to FSTR is found in the UCC checklists in Air Force Manual (AFMAN) 32-4004, *Emergency Response Operations*. Each of the twelve UCC checklists in AFMAN 32-4004 includes an item for plotting the accident on a map (5:51-5). The "One installation, one map" vision of GeoBase is perfectly suited to this task as each UCC will be able to load the CIP and their specific MDS easily and all will be looking at the same underlying map. Although AFMAN 32-4004 was published in 1995 before the term FSTR was in use, it is still applicable in FSTR planning and response.

Aircraft Accidents and HAZMAT.

The checklist items found in AFI 10-2501 and the FSTR Plan 10-2 template for aircraft accidents and HAZMAT are similar, enabling a combined analysis of these two categories. Checklist items for these events include responding to the site, designating the hazard zones, using real-time weather data to plot toxic corridor/downwind hazard area, determining evacuation needs, and containing the hazard (5:9-15, 24-65; 6:36-9, 107-21). Based on the literature review, each of items listed above are activities that have benefited from the application of GIS. The specific uses of GIS in these cases include identification of the quickest route to the scene, determining the HAZMAT in the area, identifying a cordon of appropriate size based on the hazard, identifying who needs to be evacuated and executing the evacuation, and identifying where barriers need to be built to contain contamination.

The USAF is already using GIS applications to assist with these activities. Specific examples can be found in various MAJCOMs. PACAF's release, in August 2003, of the GeoBase Toolkit is an excellent example of a GIS tool that can perform

nearly all of these activities (11:7). The GeoBase Toolkit is billed as an incident response tool that was adopted from a Security Forces specific tool called *Defensor Fortis*. The GeoBase Toolkit (GBT) includes the capability to generate cordons and automatically identify the affected facilities, streets, and intersections within the cordon area (2:1-17). This includes the ability to generate a list of the affected facilities with contact information for the facility manager (data maintained in the Automated Civil Engineer System – Real Property (ACES-RP) database) to enable evacuation notifications to begin immediately, if necessary. The ability to identify affected streets enables GBT to identify safe routes around the accident site. The appropriate intersections can be automatically plotted on the GeoBase map to indicate where Security Forces must respond to establish and maintain the integrity of the cordon. Additionally, the GBT has the ability to import plume models from VLSTRACK which is one of the tools available to calculate affected areas and generate maps of the plumes for NBC warfare attacks (not specifically for HAZMAT incidents).

The Airbase Technologies Division of Air Force Research Labs (AFRL) is currently conducting a technology assessment of a commercial product called Environmental Sensor Monitoring and Reporting neTwork (E-SMART®) (15:28-32). E-SMART® is a system with remote sensors that report concentration data for toxic industrial compounds, alarms, GPS data, and weather data. The E-SMART® software suite is a GIS application for visualizing all this data on the underlying map. The E-SMART® system is also capable of networking with HPAC to predict the areas in the hazard area (9). HPAC is another plume calculation and modeling application used in the USAF. According to the E-SMART® company website, the technology is already in use

at Tinker AFB. The Environmental Management Directorate at Tinker has deployed a system of approximately 80 E-SMART® sensors at eight sites around Tinker AFB to conduct near real-time monitoring of toxic industrial compound concentrations (10).

AFSPC has entered into the Pike's Peak Regional Data Sharing Initiative which has a stated mission to "…organize the acquisition and sharing of geographic data and technologies in support of: Homeland Security, Emergency Response, and Agency Planning/Operations" (16:10). The consortium has efforts underway to obtain tools to conduct line-of-site analysis, HAZMAT plume modeling, and route logistics (11:6). This initiative will be particularly beneficial if the USAF must respond to an off-base aircraft accident in the region.

AFSPC has also outfitted all of their Civil Engineer Emergency Response vehicles (the Civil Engineer owns fire fighting vehicles, explosive ordnance disposal vehicles, and the installation mobile command post) with AVL technology (11:6; 22). This technology provides real-time tracking of vehicles as an MDS in the Garrison GeoBase map, enabling emergency managers to assess real-time incident response (22).

Natural Disasters.

Among the checklist items found in AFI 10-2501 and AFMAN 32-4004 for natural disasters are the following items: identify resources (e.g. facilities, infrastructure) at risk, establish security cordon, identify evacuation needs and routes, assess status of emergency response resources, protect utilities by a phased shut down, conduct damage assessment, and up-channel damage reports to the SRC (5:16-17, 75-7; 6:40-1, 107-21). These are the same type of activities identified in the literature review as prime candidates for the use of GIS tools.

GeoBase applications can be used to aid in these tasks if the proper MDS are established. For example, it should be possible to incorporate the FEMA flood maps into GeoBase to evaluate potential flood areas based on expected water levels. This would enable USAF emergency managers to determine which areas need to be evacuated and which routes will still be open to conduct the evacuations. Emergency managers can use GeoBase to visually display the location of response resources (e.g. sandbags, shelter stocks, drinking water, etc) if the data is stored in functional automated information systems that are GeoBase enabled.

The utility MDS will enable quick viewing of the phased shut down requirements and enable emergency managers to track progress on the map. ACC has identified the utility system MDS (power, water, sewer, natural gas, POL, and communications) as additional layers to be included in the CIP for their installations (above the minimum features required by the Garrison Mapping CONOPS) (14:7-8). ACC expects to complete these MDS and reach Garrison GeoBase initial operating capability using funds programmed in FY04 (14:7-8). Additionally, the 38 EIG is in the final stages of identifying the requirements for the communications MDS expected to be finalized in November 2003 (12:1).

Using GeoBase to record and track spatially referenced damage reports will enable mapping the damage and viewing by all users. This can potentially negate the need to up-channel specific reports or updates as long as the higher headquarters organization has access to the damage MDS in GeoBase. In addition to streamlining the communication process, using a single map, accessible by many, reduces the potential for error and conflicting information.

IV. Recommendations and Conclusion

Although this research effort was limited, it is clear that the USAF conducts emergency management activities within the FSTR program that mirror the emergency management activities of the civilian community. It is also clear that there has been considerable research conducted and literature written on the issue of applying GIS technology to emergency management activities. Effective conduct of emergency plans and execution requires a coherent means of sharing awareness and operational risks in any situation (4:3). This situational awareness can be most effectively imparted by shared access and use of geospatial data such as imagery, maps, and locater/routing tools (4:3). The last two statements, included in a recent presentation to a combined civilian and military crowd of emergency managers, by the Chief of the Headquarters Air Force Geo Integration Office, summarize the importance of GIS applications in emergency management operations.

The USAF GeoBase program, although relatively new, is very active across the USAF and because it is grounded on a solid CONOPS, will undoubtedly be successful. However, based on the findings and considering the limitations of this research and the impacts of GIS application in emergency management, the following recommendations are made to assist the USAF in developing the GeoBase program to the full capacity available for assisting USAF emergency managers in their FSTR duties.

1. Research should be conducted to determine if all USAF functional communities are developing the proper MDS to provide their functional-specific

geospatial data in the GeoBase framework for effective FSTR planning and operations. A complete, detailed review of the FSTR checklists should be a part of this research.

2. A detailed evaluation should be undertaken to determine the value of the AVL efforts completed in AFSPC. If the cost-benefit analysis shows the AVL technology to be a good investment, then this technology should be considered for USAF-wide implementation.

3. The E-SMART® technology being used at Tinker AFB, and currently undergoing a technology assessment by AFRL, should be closely evaluated for potential expanded implementation within the USAF.

Appendix: Minimum Required CIP Layers

The following are minimum required CIP base map layers for garrison installations. The CIP for any given USAF garrison installation may include additional themes as necessary given unique mission requirements or local conditions, or may exclude layers where not applicable at a given installation. The CIP for the FOL may not necessarily contain these map layers as determined by mission requirements; refer to the ESM CONOPS for more information on the expeditionary CIP.

Area Features:

Airfield parking aprons

Base boundary/property line

Bridges

Buildings (excluding building interior blueprint/details)

Dams

Forest and vegetative cover

Helipads

Parking lots and driveways

Rivers and other water bodies

Roads (curb lines)

Runways and taxiways

Towers and storage tanks

Linear Features:

Airfield centerlines

Headwall/retaining walls

Elevation contours/ topography

Fences and barriers

Railroad lines

Road centerlines

Streams

Point Features:

Ground control points

Spot elevation points

Imagery:

1 meter resolution imagery - color or panchromatic

SOURCE: Extracted from USAF Garrison Mapping CONOPS (Ver 2.0), page 20, Appendix A

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Vita

Major Anthony A. Higdon was born at Lockbourne AFB, OH. In 1989 he graduated from Rose-Hulman Institute of Technology with a Bachelor of Science Degree in Electrical Engineering. He was commissioned in May 1989 through Detachment 218 AFROTC at Indiana State University.

He began his Air Force career as an Electrical Design Engineer assigned to the 96th Civil Engineer Squadron at Dyess AFB, TX. He has held a variety of positions at the base, Major Command, and Headquarters Air Force levels. He has served in assignments throughout the United States, Europe and Asia. His contingency experience includes a deployment to Panama and two deployments to Saudi Arabia including a tour on the Joint Task Force Southwest Asia staff. Most recently he served as a Readiness Program Manager, Headquarters United States Air Force, Office of the Civil Engineer, Pentagon, Washington DC from which he was selected as a member of the first Intermediate Development Education class at AFIT.

In 2002, Major Higdon earned a Master of Arts Degree in Management from the University of Maryland. Upon graduation from AFIT, he will be assigned as the Operations Flight Commander for the 30th Civil Engineer Squadron at Vandenberg AFB, CA.

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14. ABSTRACT

This research investigated the applications of GIS in emergency management operations specifically response to certain types of natural disasters and accidents both in general and in the USAF. The research objective was to determine the benefits the USAF can obtain from the use of GIS for emergency management operations and to examine some of the USAF efforts underway.

The research methodology consisted of a literature review of academic, commercial, and USAF documents. The research determined the effective execution of emergency plans and response requires a means to communicate situational awareness which can be effectively imparted by shared access and the use of geospatial data such as imagery, maps, and locator/routing tools.

Further evaluation of USAF Full Spectrum Threat Response plans and checklists to determine if all functional areas are developing the proper geospatial data within the GeoBase framework to effectively support emergency management operations is recommended. Additionally, an analysis of two on-going GIS program applications within the USAF is recommended to determine applicability for USAF-wide implementation.

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U	U	U	UU	34	**19b. TELEPHONE NUMBER** *(Include area code)* (937) 255-2998; e-mail: David.Bouvin@afit.edu

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